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BMJ Open Patient and system factors of time to surgery after hip fracture: a scoping review

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ABSTRACT

Objectives It is disputed whether the time a patient waits for surgery after hip fracture increases the risk of in-hospital death. This uncertainty matters as access to surgery following hip fracture may be underprioritised due to a lack of definitive evidence. Uncertainty in the available evidence may be due to differences in characteristics of patients, their injury and their care. We summarised the literature on patients and system factors associated with time to surgery, and collated proposed mechanisms for the associations.

Methods We used the framework developed by Arksey and O'Malley and Levac *et al* for synthesis of factors and mechanisms of time to surgery after hip fracture in adults aged >50 years, published in English, between 1 January 2000 and 28 February 2017, and indexed in MEDLINE, EMBASE, CINAHL or Ageline. Proposed mechanisms for reported associations were extracted from discussion sections.

Results We summarised evidence from 26 articles that reported on 24 patient and system factors of time to surgery post hip fracture. In total, 16 factors were reported by only one article. For 16 factors we found proposed mechanisms for their association with time to surgery which included surgical readiness, available resources, prioritisation and out-of-hours admission.

Conclusions We identified patient and system factors associated with time to surgery after hip fracture. This new knowledge will inform evaluation of the putative timing–death association. Future interventions should be designed to influence factors with modifiable mechanisms for delay.

INTRODUCTION

Surgery for hip fracture carries a significant risk of death with 7% dying in hospital.¹ This mortality risk depends on characteristics of patients, injury and treatment. In particular, some suggested the time a patient waits for surgery increases the risk of in-hospital death.^{2–3} Aiming at prevention of potentially harmful treatment delays, several countries set a target time for repair of hip fracture.^{4–6} However, others report no difference in the risk of in-hospital death with surgical delays.⁷ This uncertainty matters as access to surgery following hip fracture may be underprioritised due to a lack of definitive evidence.

Strengths and limitations of this study

- Scoping review according to published guidelines.
- Additional information on mechanisms for reported associations.
- Full-text review and data extraction completed by two reviewers.
- Restricted to reports of usual care with regression analysis published after 1 January 2000.
- No quality appraisal of the included studies.

Uncertainty in the available evidence may be due to differences in characteristics of patients, their injury and their care. Indeed, existing evidence identified patient and system factors associated with time to surgery after hip fracture. A patient's health status on admission or their preference to discuss their options with family may delay surgery.⁸ Conversely, delays may result from insufficient hospital resources or other issues related to the healthcare system.⁹ Failure to consider the role of these other factors may lead to conclusions based on a confounded association between timing and death.

In the current literature, there is no review of factors at play, or of the underlying mechanisms for the reported associations. This knowledge is important, as it will inform evaluation of the putative timing–death association. Further, knowledge of the underlying mechanisms will inform interventions which target modifiable factors with a negative effect on time to surgery. To address the knowledge gap, we performed a scoping review, a recognised approach to clarify a complex concept and present a means to summarise the factors involved.^{10 11} Therefore, the aims of this review were (1) to identify patient and system factors of timing of surgery after hip fracture, and (2) collate the proposed mechanisms for the reported associations.

METHODS

We followed the widely recognised scoping review framework by Arksey and O'Malley¹² and subsequent recommendations^{11 13} for conducting and reporting scoping reviews. In keeping with this recommended framework, we collated the evidence on a topic of interest and do not critically appraise the methodology of reviewed articles.¹¹⁻¹³

Levac *et al* acknowledged that scoping review *research questions which are too broad in nature lacked direction, clarity and the focus needed to inform subsequent stages of the research process, such as identifying studies and making decisions about study inclusions*.¹¹ They recommend *combining a broad research question with a clearly articulated scope of inquiry*.¹¹ As such we identified the broad research question 'what patient and system factors are associated with timing of hip fracture surgery?' within our scope of inquiry of adults over the age of 50 years, who received usual care, after admission to acute care with non-pathological low energy hip fracture. We extended this framework by collecting information on the underlying mechanisms for found associations.

This scoping review summarised published literature and ethical approval was not required.

Study selection

One reviewer searched MEDLINE, EMBASE, CINAHL and Ageline using peer-reviewed combinations of key search terms: time to surgery, hip/femoral fracture, regression analysis and observational study design (see online supplementary file 1). Studies were first screened for eligibility according to title and abstract using standardised inclusion criteria (table 1). The reference list of included articles was screened for additional articles. To assess the accuracy of article selection, a second reviewer screened the first 50 studies for eligibility according to title and abstract using the standardised inclusion criteria. There was no disagreement between reviewers. Subsequent studies marked as 'maybe for inclusion' were screened by a second reviewer for eligibility. Studies that appeared suitable were selected for

full-text review. Full-text review and data extraction was completed by the two reviewers.

We reviewed studies published in 2000 or later to minimise the potential biasing effects of demographic ageing,¹⁴⁻¹⁷ surgical advancements¹⁵ and changes in delivery of hip fracture care.¹⁸⁻²⁰ In particular, advances in surgical implants, care structures such as surgeon level of experience, and care processes such as discharge and access policies.^{1 15} We did not include intervention-based studies on the premise that they do not reflect time to hip fracture surgery following usual care. Finally, only studies reporting regression analysis were included as a regression model was deemed a proxy for the direction of the reported association.

Using a standardised data collection, one reviewer extracted author's name, publication date, timing of surgery relative to the hip fracture admission, and patient and system factors of time to surgery (from univariate and multivariate regression analysis) in each article. The significance of statistical associations between the factors and mortality was derived from the 95% CIs reported in the articles. The proposed mechanisms for the effect of patient and system factors on timing of surgery after hip fracture were extracted from discussions by one reviewer. The accuracy of extraction was assessed by a second reviewer.

Collating, summarising and reporting results

Patient and system factors of time to surgery studied in the reviewed articles are summarised in table 2. Factors with a proposed mechanism of their effects on time to surgery are summarised in table 3.

RESULTS

Search results

The searches produced 930 articles for initial title and abstract screening (figure 1). We excluded 907 articles on title and abstract screening. We identified three additional articles from screening of reference lists. We included 26 articles in this review.^{9 21-34}

Among the included articles, patient and system factors for timing of surgery beyond 48 hours, beyond 36 hours and beyond 24 hours were reported by 17,^{9 21 23-27 29-38} 1³⁹ and 3²² studies, respectively. A further five studies reported on patient and system factors for continuous time to surgery.^{28 40-43}

Patient factors of time to surgery

We identified 10 patient factors of time to surgery after hip fracture (table 2). Five factors (fracture type, preadmission residence, sex, concomitant pelvic fracture and functional status) were studied by only one study included in this review. There is general consensus that time to surgery after hip fracture is associated with age, anticoagulant therapy, antiplatelet therapy, clinical stability, comorbidity and socioeconomic status. One study reported no association between concomitant

Table 1 Inclusion criteria for the literature search.

Term	Include
Study population	Men and women ≥50 years of age with non-pathological low energy hip fracture
Study design	Observational studies
Factors	Patient and system factors of time to surgery
Associations	Estimates from regression analysis
Outcome	Time to surgery
Date	Between 1 January 2000 and 28 February 2017
Language	English
Geography	Worldwide

**Table 2** Articles studying time to surgery after hip fracture in relation to patient and system factors

Author	Age	Anticoagulant/ antiplatelet*	Clinical stability	Fracture type	With pelvic fracture	Comorbidity	Preadmission residence	Sex	Functional status	Race	sest	Care pathway	Insurance status	Hospital type	Hospital volume	Medical test	Out-of-hours admission	OR availability	Pay for performance	Prioritisation	Surgery type	Anaesthetic type	Surgeon availability	Transfer	Hospital region
Barone <i>et al</i> ²¹											✓														
Charalambous <i>et al</i> ²²		✓	✓													✓	✓	✓		✓					
Colais <i>et al</i> ²³			✓																✓						
Colais <i>et al</i> ²⁴											✓														
Elkassabany <i>et al</i> ²⁵														✓	✓										
Fantini <i>et al</i> ²⁶	✓	✓	✓			✓								✓			✓					✓			
Gleason <i>et al</i> ²⁷		✓																							
Holt <i>et al</i> ²⁸			✓																						
Lizaur-Utrilla <i>et al</i> ²⁹		✓				✓																			
Miura <i>et al</i> ³⁰												✓													
Moran <i>et al</i> ³¹		✓	✓																						
Neufeld <i>et al</i> ³²		✓	✓	✓		✓		✓	✓	✓											✓	✓			
Orosz <i>et al</i> ³³			✓			✓										✓		✓					✓		
Ranhoff <i>et al</i> ³⁴	✓																								
Ricci <i>et al</i> ³⁵		✓	✓					✓								✓	✓								
Richardson <i>et al</i> ³⁶													✓	✓					✓						
Ryan <i>et al</i> ³⁷						✓				✓				✓											✓
Samuel <i>et al</i> ³⁸			✓		✓									✓											
Shah <i>et al</i> ³⁹		✓	✓			✓								✓											
Siegmeth <i>et al</i> ⁴⁰		✓	✓																						
Speck <i>et al</i> ⁴¹		✓	✓													✓									
Ventura <i>et al</i> ⁴²	✓	✓				✓						✓					✓	✓							
Vidán <i>et al</i> ⁴³		✓	✓															✓							
Zeltzer <i>et al</i> ⁴⁴						✓											✓				✓			✓	
Among all	2	7	13	1	1	8	1	2	1	2	2	2	1	4	1	4	6	4	2	1	1	3	1	1	1

*Anticoagulant/antiplatelet therapy requiring reversal on admission.

†SES, socioeconomic status.

Table 3 Proposed mechanisms for the effect of patient and system factors on timing of surgery after hip fracture

Factor group	Factor	Mechanism
Patient	Age	Older adults require medical stabilisation before surgery more often than younger adults. ²⁵
	Anticoagulant/antiplatelet therapy	Anticoagulant/antiplatelet therapy increases the risk of surgical bleeding. Levels of therapy are reduced before surgery. ^{22 25 32 41}
	Clinical stability	Higher American Society of Anesthesiologists Score associated with need for medical stabilisation before surgery. ^{25 27 28 33 45}
	Sex	Men more often require medical stabilisation before surgery. ²⁸
	Socioeconomic status	Longer time to surgery for the most disadvantaged may be related to poor baseline clinical conditions with need for medical stabilisation before surgery. ²¹
	Comorbidity	Patients with comorbidity more often require medical stabilisation before surgery. ³⁰
	Race	Hospitals that treat higher proportion of minority groups may not have enough access to specialists. ³⁰
	Out-of-hours admission	There are fewer available resources after hours and on weekends than for weekdays. ^{28 32}
System	Medical test	Patients awaiting investigations are delayed to surgery. ^{22 37}
	Prioritisation	The availability of resources will influence the prioritisation of hip fracture surgery over other surgeries. ²²
	Surgery type	The longer time to surgery for cases treated with arthroplasty compared with fixation may be due to availability of a surgeon experienced in arthroplasty or implants not available 'on the shelf'. ³⁴
	Transfer	Patients are delayed while transfer is coordinated and executed. Patients undergoing transfers are more likely admitted to the treatment site later in the day. Patients admitted later in the day need to wait for resources to become available for surgery. ⁴⁶
	Insurance status	Hospitals that treat higher proportion of minority groups may not have enough access to specialists. ³⁰
	Hospital type	Crowding at teaching and large hospitals may explain delays to surgery. ³⁰
	Hospital volume	Allocation of resources for hip fracture may vary by hospital volume sites. ³⁵
	Hospital region	Excess demand may lead to logistical challenges in scheduling patients. ³⁰

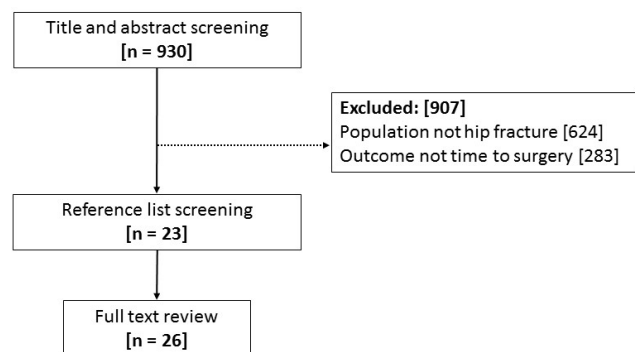


Figure 1 Flow chart of the literature retrieval, review, exclusion and selection.

upper limb fracture, injury severity score, alcoholism, or obesity and time to surgery after hip fracture.⁴⁴ We identified seven factors with proposed mechanisms underlying the association between patient factors and timing of surgery after hip fracture (table 3, figure 2). Surgical readiness was the proposed mechanism for the association between age,²⁵ anticoagulant therapy,^{22 25 32} antiplatelet therapy,³² clinical stability,^{25 27 28 33 45} sex,²⁸

comorbidity³⁰ and socioeconomic status²¹ with time to surgery after hip fracture. We also displayed the patient pathway that shows where the patient factors may influence the care process (figure 3). The majority of patient factors are determined before fracture or at the time of injury. Clinical stability is established on assessment after arrival at the emergency department.

System factors of time to surgery

We identified 14 system factors of time to surgery after hip fracture (table 2). A total of 11 factors were studied by only one study included in this review. There is general consensus that time to surgery after hip fracture is associated with out-of-hours admission, operating room availability and surgery type. One study reported no association between the need for echocardiogram and time to surgery after hip fracture.³⁷ Two studies reported no association between clinical pathway and time to surgery after hip fracture.^{42 43} We identified nine factors with proposed mechanisms underlying the association between system factors and timing of surgery after hip fracture (table 3, figure 2). Resource availability was the proposed mechanism for the association between out-of-hours admission,^{28 32} medical test,²² prioritisation,²² surgery

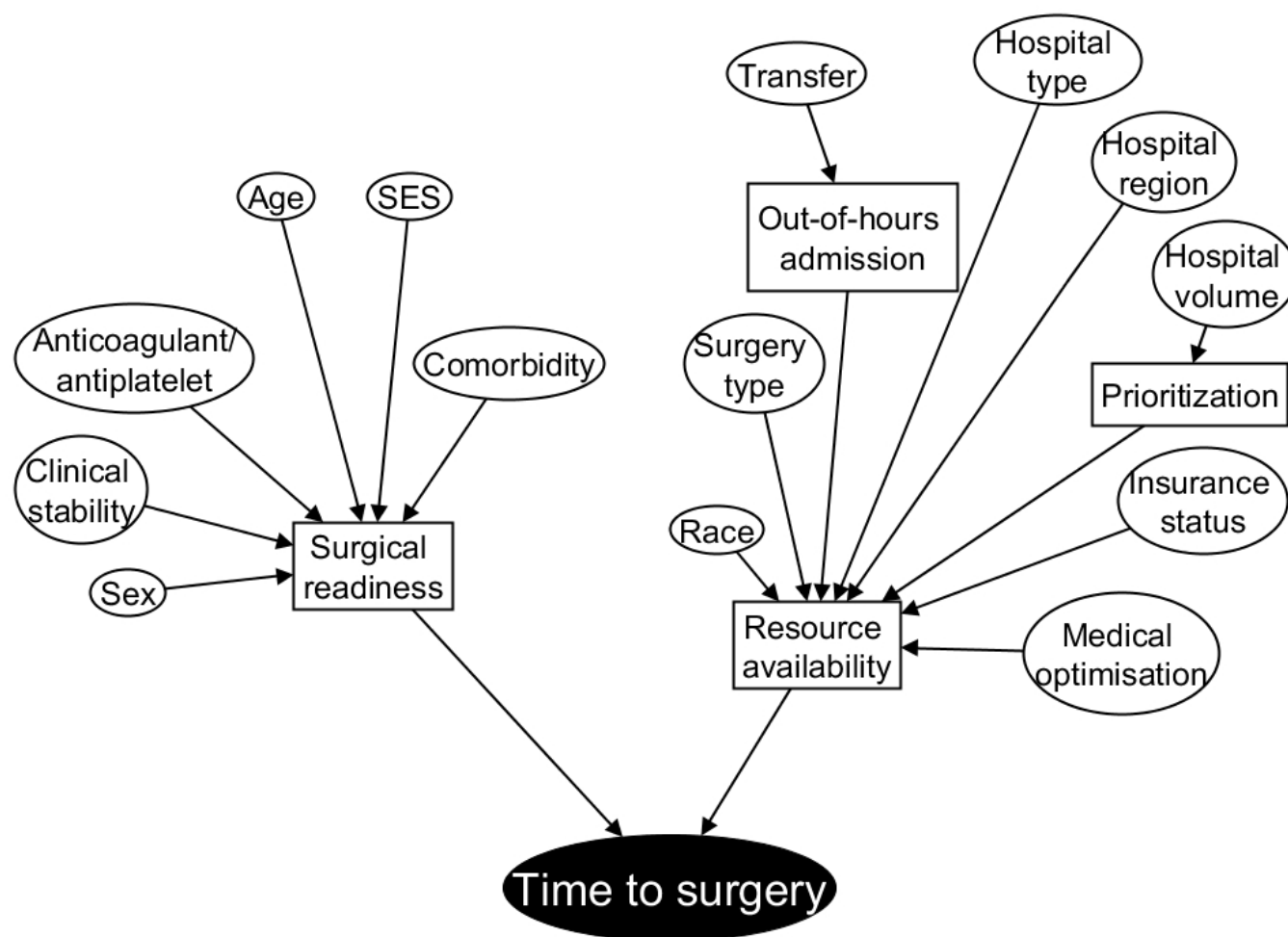


Figure 2 Mechanisms proposed for patient and system factors in reviewed articles. Black node indicates the outcome. Square box indicates a measurable mediator. SES, socioeconomic status.

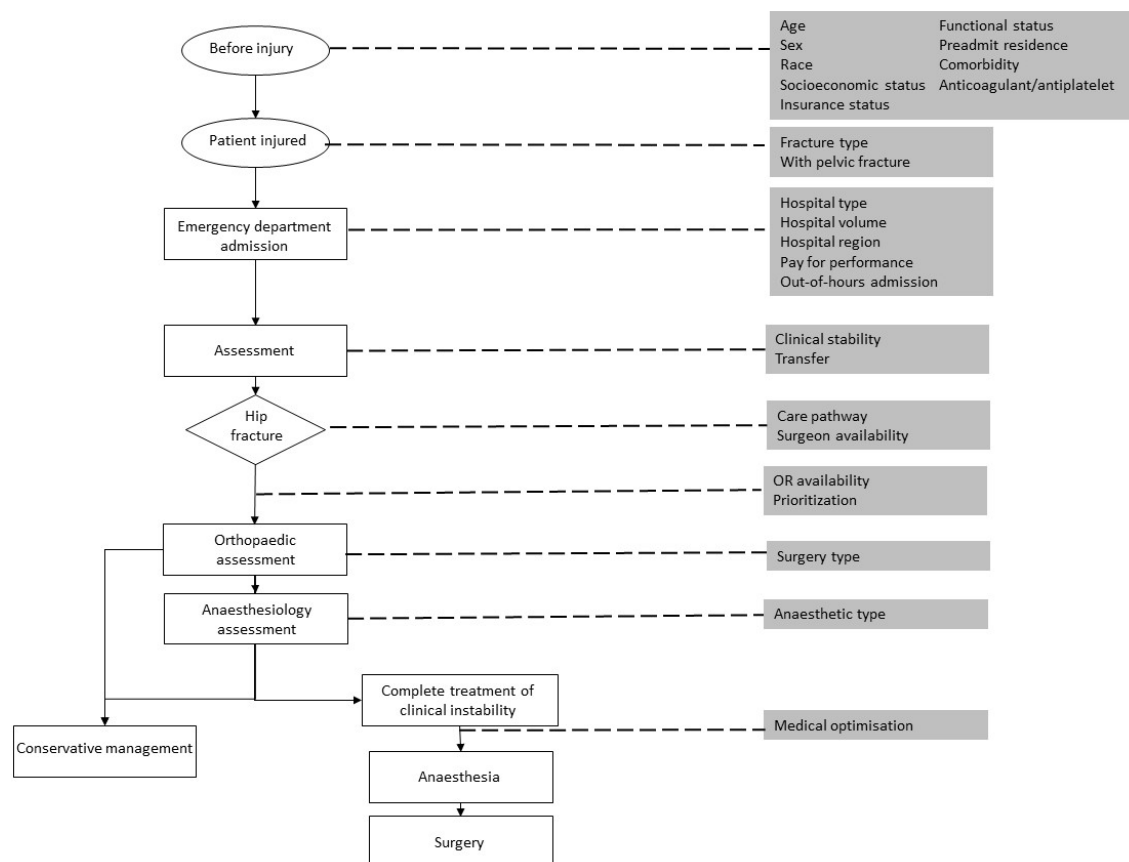


Figure 3 Example of hip fracture care process map, linked to patient and system factors associated with timing of surgery. Circles represent non-care events, white squares represent care processes, and diamond represents care diagnosis. Grey squares represent patient and system factors associated with timing of surgery.

type,³⁴ insurance status³⁰ and hospital type and region³⁰ with time to surgery after hip fracture. Out-of-hours admission was the proposed mechanism for the association between transfer and time to surgery after hip fracture.⁴⁶ Prioritisation was the proposed mechanism for the association between hospital volume and time to surgery.³⁵

We also displayed the patient pathway that shows where the system factors may influence the care process (figure 3). Insurance status is determined before fracture. The hospital type, volume and region, payer status, and day and time of admission are established on arrival at the emergency department. Clinical stability and the need for transfer are established on assessment in the emergency department. With a diagnosis of hip fracture the care pathway is selected, and availability of surgeon experienced in the procedure determined. The patient is then prioritised according to local policy for access to the operating room. The orthopaedic and medical team assess the patient, and the type of surgery selected. The anaesthesiologist then determines the anaesthetic type. Treatment of clinical instability is completed for medical optimisation, anaesthesia and surgery.

DISCUSSION

This review summarised the information available on proposed mechanisms for reported association between patient and system factors and time to surgery after hip

fracture. This review pointed to surgical readiness, available resources, demand, prioritisation and out-of-hours admission as mechanisms for the association between patient and system factors with time to surgery after hip fracture.

Patients may be appropriately delayed to surgery to enable correction of clinical instability (as distinct from stable comorbidity).^{22 25 31 32 47–49} However, there is no consensus on which clinical features represent appropriate delays. The clinical guideline of the UK National Institute for Health and Care Excellence suggested that patients may be appropriately delayed by the following medical conditions and treatments: anaemia, anticoagulation, volume depletion, electrolyte imbalance, uncontrolled diabetes, uncontrolled heart failure, acute cardiac arrhythmia or ischaemia, acute chest infection, or exacerbation of a chronic chest condition.²³ Siegmeth and colleagues did not include exacerbation of a chronic chest condition; however, they included gastrointestinal haemorrhage, uncontrolled hypertension and need for echocardiography, as appropriate medical reasons for delay.³¹ The list of medical reasons for delaying hip fracture surgery proposed by Devereaux is even more extensive.⁴⁷ Further, patients may choose to delay surgery for other personal reasons. There is a need for consensus on what represent appropriate delays before surgery.



Patients admitted to care settings with less resources available such as operating room,^{9 22 32} specialist^{28 34} or laboratory test^{22 28 34} experience longer time to surgery for non-medical reasons.⁵⁰ These potentially avoidable longer times to surgery prolong exposure to immobilised and inflammatory states which in turn can lead to potentially fatal complications.⁵⁰ Where the surgery requires additional resources such as a surgeon with arthroplasty experience or implants not available on the shelf the patient may be delayed further.³⁴ In fact, some settings have no orthopaedic trauma service at all and patients require transfer before definitive care.³⁴ Longer time to surgery due to resource availability may be considered inappropriate where the patient is required to wait despite being surgically ready. Future intervention studies should target these modifiable system factors for delay to ensure timely appropriate care.

There are limitations to this review. In keeping with the scoping review framework, we collated the evidence on a topic of interest and do not critically appraise the methodology of the reported studies.¹² Future systematic reviews focusing on specific factors identified in this review should include an appraisal of the methodologies. We excluded articles preceding 1 January 2000 and after 28 February 2017. It is therefore possible that we under-report patient and system factors associated with the timing of hip fracture surgery. We excluded studies which did not indicate a regression analysis in their title, abstract or MeSH terms. We also excluded intervention studies as these did not reflect our scope of inquiry. It is therefore possible we excluded articles not indexed by analysis type or study design relevant to the current review. Moreover, we may have excluded secondary analyses of factors of time to surgery following usual care within intervention studies. These exclusions may relate both to factors of time to surgery after hip fracture and underlying mechanisms for their association.

CONCLUSION

We identified patient and system factors of timing of surgery and collated the proposed mechanisms for the reported associations. We concluded that surgical readiness, available resources, out-of-hours admission and prioritisation as mechanisms for the association between patient and system factors with time to surgery after hip fracture. This new knowledge may be used to inform evaluation of bias in a future systematic review of the putative timing–death association. Further, future studies should be designed to intervene on identified factors with modifiable mechanisms for delay.

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Contributors All authors contributed to the conception and design of the review. KJS contributed to the search development. In addition, KJS and YFV identified

papers, and completed data extraction. KJS, BS, YFV and PG contributed to the interpretation of the data extracted. KJS and YFV drafted the manuscript. All authors critically revised the manuscript and approved the final version for submission.

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Competing interests PG has received grants from the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada, the Canadian Foundation for Innovation and the British Columbia Specialists Services Committee for work around hip fracture care not related to this manuscript. He has also received fees from the BC Specialists Services Committee (for a provincial quality improvement project on redesign of hip fracture care) and from Stryker Orthopedics (as a product development consultant). He is a board member and shareholder of Traumis Surgical Systems Inc. and a board member of the Canadian Orthopedic Foundation. He also serves on the speakers' bureaus of AO Trauma North America and Stryker Canada. KJS, BS and YFV declare they have no competing interests.

Patient consent Scoping review of published literature.

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Data sharing statement Data are collected from published literature, the references of which are detailed in the manuscript.

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Patient and system factors of time to surgery after hip fracture: a scoping review

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